1 INTRODUCTION

1.1 Background of the study

Biomass energy is currently sought as a major source of alternative energy. It is a renewable, potentially sustainable and environmentally benign source of energy. Biomass contribute about 12% of today's world primary energy supply, while in many developing countries, its contribution range from 40% to 50% (Tye et al., 2011). World production of biomass is estimated at 146 billion metric tons a year (Balat and Ayar, 2005). Biomass is still the world's second largest source of renewable energy. Although the applications of renewable energy grow lately, the limitation of application is due to the high cost and poor technology reliability. Under the development and evolution, the latest technology was biomass torrefaction for commercialization. Commercial development of torrefaction is currently in early phase. Several of the companies are moving toward commercial market introduction. Furthermore, the woody biomass is more light compare to the other heavy products. woody biomass ease to bring everywhere, even carry in the flight cabin.

Biomass can be used in virtually any energy application where fossil fuel is used. Biomass and its utilization have been intimately associated to renewable energy in the recent years (Chew and Doshi et al., 2011). However, the properties of biomass is not desirable such as high moisture content low energy density, tenacious and fibrous in nature, become a barrier to its competitiveness in the energy generation market. Therefore, one of the viable option to overcome the issues associated with biomass feedstock is to carry out a pre-treatment process is called torrefaction. Torrefaction is the slow heating of biomass in an inert or reduced environment to a maximum temperature of approximately 300 ℃ (Tumuluru et al., 2011). Torrefaction also can be defined as thermal process applied to the wood to obtain the reaction to convert them into high quality of solid biofuel that is more suitable to combustion pyrolysis or gasification in the range of temperature 200℃ to 300℃. The progress is eliminate the water content portion from the organic sample which is complete the calibration process. The mass of sample is loss and the structure is broken by depolymerisation process. Therefore, this produces a solid fuel which is called biocoal.

1.1.2 Biomass as a potential renewable source of energy

The versatility of biomass as a source of energy for heat, power and transport has been viewed as a source of energy that has the potential to offset fossil fuel use and continues to attract worldwide attention (McKay, 2006; Nowakowski *et al*., 2007). The IEA Bioenergy Task 40 reported that most of the biomass use globally is accounted for inefficient residential use (66%) that is mainly in developing countries for cooking and heating. Industry is the second largest, followed by electricity and transportation (IEA, 2013).

Table 1.1 presents a list of countries that uses biomass in the industrial sector, where Brazil, India and the United States present the top three who use the largest amount of biomass (IEA, 2013). With regards to UK, Ares (2013) mentioned that in 2011, 0.6% of its generation of energy comes from dedicated biomass. These fuels include straw and short rotation energy crops and the rest was animal biomass. The author also reported that half of the biomass was imported while the animal biomass is usually home produced. The use of dedicated plant biomass has reached more than double over the past four years (Ares, 2013). On the other hand, UK often uses wood for heating in homes and industry rather than for electricity generation. Therefore, Ares (2013) stated that UK is a net exporter of wood and wood waste for energy.

In the transportation sector, ethanol is the major transport biofuel in the US and Brazil while biodiesel is widely used in EU area (IEA, 2013a). Almost half of the global liquid biofuels production are consumed by the US (43%) as recorded in 2011 and interestingly, 87% of the ethanol produced in Brazil is used as fuel (IEA, 2013).

Table 1.1 Countries that use biomass in the industrial sector (IEA, 2013a)

No.	**Country**	**Share of global use (%)**
1	Brazil	18
2	India	16
3	United States	16
4	Nigeria	5
5	Canada	4
6	Thailand	4
7	Indonesia	4
8	Democratic Republic of Congo	3
9	Sweden	2
10	Pakistan	2
11	Finland	2
12	Australia	1
13	Germany	1
14	France	1
15	Japan	1
Other Countries		20
World		100

1.2 Motivation

Wood waste is reused to create new technologies to convert biomass waste nowadays. It contributes to reduce the greenhouse gas effect. However, high cost of particle synthesis production and conversion technologies is the disadvantages of the biomass. Woody biomass like energy source has its advantages and disadvantages after processing of torrefaction. Therefore, this proposed study can reduce the amount of abundant wood waste from the industries by adding the value of the solid material and avoid pollution to the environment.

The torrefaction technology is the latest technology brings attractive financial returns to many investors. Hence, they are poised to pour millions of dollars into building new plants especially in European Union. The European Union (EU) aims to achieve